U.S. Department of Agriculture Agricultural Research Service Vol. 33, No. 5, May 1985

Agricultural Research

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Poultry and World Nutrition

It was estimated by the United Nations Food and Agriculture Organization that in the mid-1970's, 22 percent of the population in developing countries were undernourished. And the number of malnourished or those facing outright starvation is believed to be increasing, although the number varies from year to year depending on crop conditions in different parts of the world.

By the year 2000, the world's population may climb to 6.2 billion. Each day there are 300,000 more people to feed than the day before. Finding ways to feed these people is clearly one of the greatest challenges we face today.

An inadequate supply of high-quality protein is one of the principal causes of the malnutrition which affects about one-fifth of the population in developing countries. Protein is essential in human nutrition, and animal proteins generally contain higher proportions of some essential amino acids—such as methionine—than do vegetable proteins. They also contribute iron, calcium, many vitamins, and other micronutrients. Animal proteins are the principal source of an essential vitamin, B-12.

Protein from poultry meat and eggs can play a role in reducing malnutrition in developing countries.

They are already significant sources of food protein throughout the world, and their use is increasing. This is because of their low cost and wide acceptance—there is no major taboo to poultry consumption as there is with beef or pork among various peoples.

Another great advantage of poultry over other livestock is their superior efficiency in converting feed nutrients into edible products. So, in total intake and output, meat and egg production from poultry are second only to milk production from dairy cattle in their efficiency of conversion of feed to energy, protein, or edible product.

In developing countries, particularly those with pastoral husbandry, the main source of feed for poultry is from scavenging of plants, insects, and small animals. Also, poultry utilize waste from the kitchen, from the harvest of crops, and from the home slaughter of animals. So, even under pastoral conditions, poultry make use of "waste" products or products unsuitable for human consumption.

Poultry form a "bank" of protein and other nutrients that contribute to food reserves in times of short-term food crop crises.

Populations of poultry are more readily built up after a disaster than are other livestock because of their shorter reproductive cycle. Poultry have the added advantages of being small enough to be eaten at one meal—an advantage for areas without refrigeration—and a convenient size for barter.

But many factors, such as lack of resources, markets, research, and production technology, limit poultry output, especially in developing countries.

In contrast to rearing poultry under intensive confinement as many developed countries do, most of the developing countries still rear poultry using a pastoral, free-range system. These are often mixed-cropping systems combining a close interaction of animals and plants. However, the technology of large-scale, modern, highly efficient poultry production has proven rather easy to transfer to developing countries.

After all, poultry production in the more advanced countries did not undergo any great technological developments until the beginning of this century. The invention of large incubators, lamp-heated brooders, techniques to determine the sex of day-old chicks, improved feeds, and intensive rearing contributed to a revolution in poultry farming in the United States. In 1930, less than 50 percent of the chicks were mechanically incubated and hatched in hatcheries. By 1938, hatchery production had climbed to 66 percent, and it reached 88 percent by the late forties. Integration of poultry breeding, growing, and processing facilities led to substantial improvements in production efficiency as well as genetic improvements in breeds. (See Turkey and Stud Farms, p. 6.)

What happened in the United States can happen in developing countries. In spite of the factors currently limiting poultry output, it is likely that protein from poultry meat and eggs will figure more in the diets of people of the world than protein from milk or other animals. This makes poultry most important to human health and well-being throughout the remainder of this century.

H. Graham Purchase
Special Scientific Adviser to the Director
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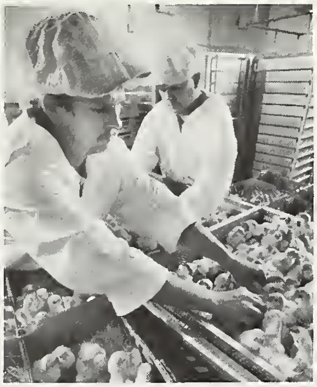
Agricultural Research



Turkey chicks, 50,000 a day, are hatched at Cooper Hatchery, Oakwood, OH—fathered, through artificial insemination, by superior tom turkeys raised on Cooper's modern turkey stud farm. Discoveries from Integrated Reproduction Management projects by the Agricultural Research Service helped make turkey stud farms possible. Story begins on page 6. (0585X453-30A)

NOTE to USDA Extension Service subscribers: Beginning with the June/July 1985 issue of ***Agricultural Research****, distribution to ES readers will be made through state publication distribution officers rather than through the U.S. postal system. This change will significantly reduce the cost of mailing the magazine.*

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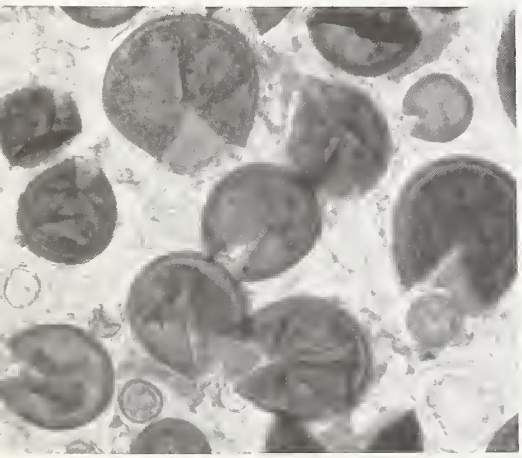
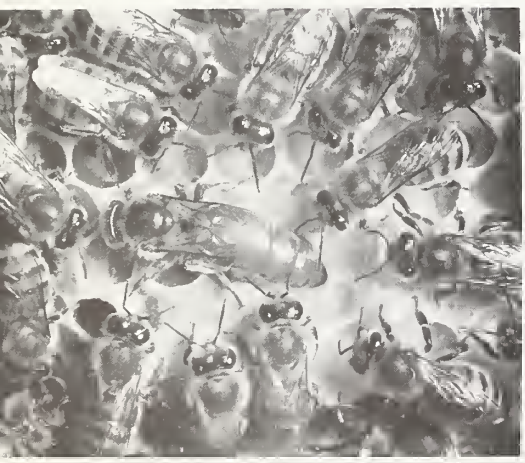
Good Housekeeping Means Healthier Bees

An unkempt hive can mean the difference between life and death for honey bees, so Agricultural Research Service scientists are helping bees tidy up.

"We have bred honey bees that are twice as tidy as others," says Martha Gilliam, a microbiologist at the Carl Hayden Bee Research Center in Tucson, AZ.

Gilliam and Stephen Taber III, an entomologist, selected queen bees from two groups—good housekeepers that removed all dead within 24 hours and poor housekeepers that removed 30 percent or fewer of their dead the first day.





Top: Photomicrograph of honey bee larvae that have been turned into black mummies by chalkbrood disease, Ascosphaera apis. (PN-7160)

Above: Honey bee workers surround queen on brood comb. (Photo courtesy of Grant Heilman.)

The speed with which dead are removed is important to bees' health, because infected bees can spread brood diseases.

Gilliam artifically inseminated the queens with sperm from a random group of drone bees and then moved the pregnant queens to new hives, where they laid their eggs.

The new hives were sprayed with chalkbrood fungus, to see how the two groups fared. In every instance, Gilliam says, the good housekeepers were less infected than their messy neighbors.

"We conducted another experiment at the same time to test bees' uncapping behavior. This is when bees chew away the wax end of cells in the honeycomb that contain diseased larvae," Gilliam says.

She found that the good housekeepers uncapped all the cells within 48 hours, while sloppy bees didn't get the job done even after 96 hours.

"In only three generations of testings, we got bees that were at least twice as efficient in their uncapping and removal activities. I think the potential for further improvement definitely exists," Gilliam says.

Gilliam says the bee research center's techniques for testing bees' hygienic behavior may help breeders and keepers control brood diseases by identifying and replacing queen bees that bear poor housekeepers.

Control of brood disease is critical because bees contribute so much to the economy. Marshall D. Levin, director of the Carl Hayden center, says bees pollinate crops worth nearly $19 billion a year, besides producing honey and beeswax worth $140 million a year.—**Dennis Senft,** Albany, CA.

Martha A. Gilliam is located at the USDA-ARS, Carl Hayden Bee Research Center, 2000 E. Allen Road, Tucson, AZ 85719. ■

Steam Blanching Improves Canned Beans

Steam does a better job of preparing dry beans for canning than boiling does.

That's the conclusion reached by researcher Stephen R. Drake after a study at the Vegetable Crops Production Research Laboratory in Prosser, WA.

Drake used six different dry bean varieties to compare the quality of steam-blanched and water-blanched beans and to determine quality differences that may occur among varieties.

Drake says, "We found that the steam-blanched beans were plumper and firmer and had higher drained weights and better color than beans blanched with hot water. For both processes, canning quality varied according to bean variety and amount of blanching."

Not only is quality better with high-pressure steam blanching, but the method also saves time and energy, taking only 25 seconds compared to about 3 minutes for boiling.—**Howard Sherman,** Albany, CA.

Stephen R. Drake is now at the USDA-ARS, Tree Fruit Research Laboratory, Wenatchee, WA 98801. ■

A Touch of Bran

Spaghetti made with 10 percent bran has more than three times the dietary fiber of regular spaghetti. The addition of bran also "significantly increases" protein, iron, calcium, manganese, magnesium, phosphorus, and zinc content, according to ARS food technologist Vernon L. Youngs at Fargo, ND. He says levels of these minerals average more than 40 percent higher.

Spaghetti is made from the inner kernel (endosperm) of durum wheat that is ground into a granular form called semolina. Bran sur-

rounds the kernel and is removed in milling the wheat. Youngs and graduate student Rhoda Kordonowy made bran spaghetti by adding the bran back to the semolina.

How does it taste? Youngs and Kordonowy asked a taste panel of 51 volunteers to answer that question.

"Those who usually prefer whole wheat bread to white bread said they preferred 10 percent bran spaghetti over regular spaghetti," says Youngs. "Panelists who prefer white bread gave the bran spaghetti a low rating. Regular spaghetti generally rated better in the three factors measured—flavor, texture, and color," he admits.

"Bran spaghetti is not going to replace traditional spaghetti, but it could offer a broader selection of products for those people seeking a way to increase the level of fiber and minerals in their diet."

USDA dietary guidelines recommend a decrease in consumption of sodium, fat, and simple carbohydrates and an increase in consumption of fiber and complex carbohydrates, he says. Spaghetti is low in sodium, fat, and simple carbohydrates and contains a high level of complex carbohydrates. The addition of bran provides the fiber, improving the nutritional match of spaghetti to the dietary guidelines even more, he notes.—**Ray Pierce**, Peoria, Ill.

Vernon L. Youngs is located at the ARS Hard Red Spring and Durum Wheat Quality Research Unit, North Dakota State University, Fargo, ND 58105. ■

A Cheap Field Test for CAP in Milk

Federal inspectors could soon have an easy-to-use test to detect chloramphenicol (CAP)—an antibiotic that is restricted from use in dairy cattle and meat animals.

Agricultural Research Service chemist Daniel P. Schwartz and colleagues at Philadelphia, PA, developed the test—which costs only about 25 cents in materials—to detect possible illegal use of the drug. The test could be used on farms or at milk-bottling plants.

In the United States, legal use of CAP is restricted to control of respiratory and other clinical infections in animals that are not raised to produce human foods—horses or household pets, for example. Chloramphenicol is reported to cause aplastic anemia in some susceptible people.

Schwartz developed the test in response to regulatory agencies' concerns that some dairy cattle may be treated with the antibiotic.

Schwartz' team cooperates with USDA's Food Safety and Inspection Service to develop tests like the one for CAP for measuring antimicrobial drugs in milk, urine, blood, tissue residues, and animal feeds.—**Stephen Berberich**, Beltsville, MD.

Daniel Schwartz is in Food Contaminant Research at the USDA-ARS Eastern Regional Research Center, 600 East Mermaid Lane, Philadelphia, PA 19118. ■

Chemist Daniel Schwartz uses a new, inexpensive technique to test for traces of the antibiotic chloramphenicol (CAP) in milk. Milk sample flows through a pipette containing non-ionic resin which traps certain chemicals. The trapped chemicals are removed and a sensitive color test reveals whether CAP is present. (0185X0029-16A)

Pinpointing Chemical Residues

When honey bees die from accidental pesticide poisoning, beekeepers are often at a loss to pinpoint the exact chemical cause of bee deaths, says Agricultural Research Service chemist Arthur J. (Jack) Harvey. A new laboratory test that Harvey developed may help solve this problem, at least when the chemical responsible is 1 of up to 31 organophosphate insecticides.

The identification technique can be used to find members of this group of pesticides in both fatty and nonfatty samples. So far, Harvey has used it to locate specific insecticides in bees, honey, beeswax, and plants the bees forage.

He believes the technique can even be used to check for the presence of organophosphate insecticides in food and feed supplies.

An instrument found in many scientific laboratories—a gas chromatograph—is the key tool in the identifications. It "fingerprints" the chemical constituents in a sample, such as dead bees, so that any organophosphate present can be recognized.

Harvey is currently developing similar techniques that can be used to identify other pesticides, such as the carbamate, pyrethroid, and chlorinated groups.

Information from this technique will aid beekeepers and provide another safety test for our food and feed supplies, Harvey says.—**Dennis Senft**, Albany, CA.

Jack Harvey is located at the UDSA-ARS Honey Bee/Pesticide Research Unit, University of Wyoming, Laramie, WY 82071. ■

245 Turkey Stud Farms //

Left: Tom turkeys from a flock at the ARS Avian Physiology Laboratory at Beltsville, MD, provide semen for research programs. Birds are typical Large White commercial turkeys. (0585X388-31A)

Top: Avian Physiology Laboratory research leader Thomas Sexton (right) and poultry flock supervisor Stewart Green add Beltsville Turkey Semen Extender to turkey semen to prolong its naturally short storage life. (0585X478-24A)

Above: Sexton says the viability of turkey sperm can now be maintained for up to 24 hours at low temperatures with the Beltsville extender. (0585X478-28A)

An IRM Story For Breeders, Consumers

Turkey for holiday tables, lunch pails, and assorted processed foods is rising rapidly in quality, say industry and research experts, thanks to new turkey stud farms and to a firm "nudge" by Agricultural Research Service scientists.

Turkey stud farms are a major success as a result of a new research concept called integrated reproduction management (IRM). For farmer or animal scientist, IRM simply means applying new knowledge gained through research to livestock reproductive efficiency.

Each year since 1982, ARS has funded about $1.3 million for more than 25 livestock and poultry IRM projects. One such project, to make artificial insemination useful to turkey breeders, has so far led to centralizing and reducing the number of male turkeys to a handful of locations. That, in turn, has the potential of saving $3.5 million in labor and feed costs per year, according to a recent ARS study.

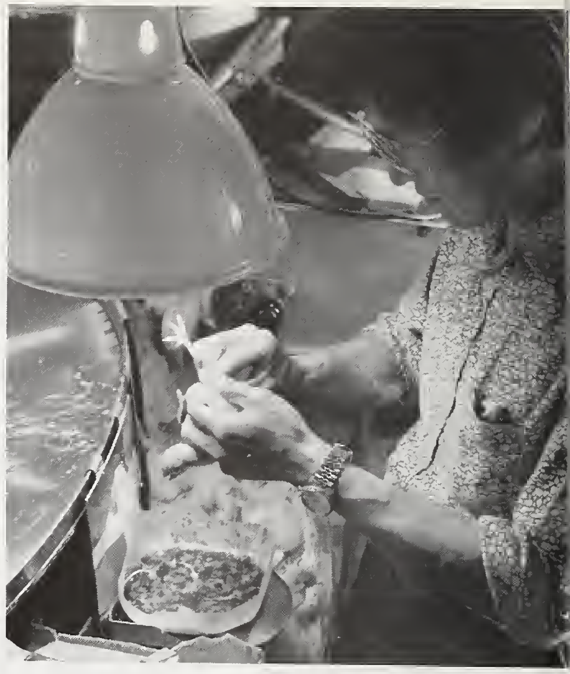
But, wait, wait! A turkey stud farm? Champion toms living out their autumn days in bluegrass luxury of Kentucky pastures? No, no, no—the imagery is all wrong! The ungainly, gobbling turkey is certainly no Seattle Slew or Secretariat, the magnificent ex-racehorses now pampered and protected for high-priced breeding fees.

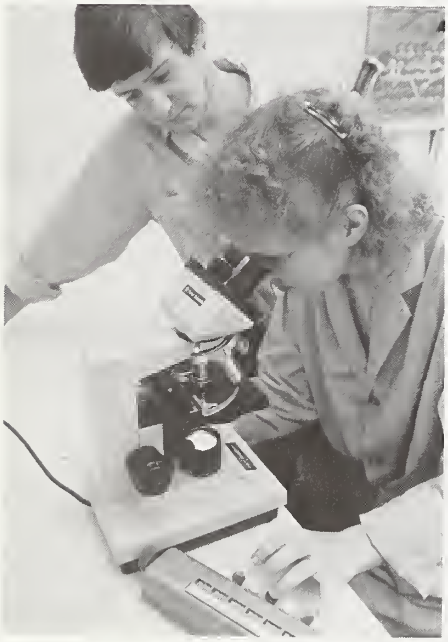
No, on the face of it, Tom Turkey is not the same. Or, is he? In terms of breeding, or in the value of superior genes for siring higher producing animals, the turkey stud farm serves the same purpose as the more famous equestrian services.

The turkey industry is one of the fastest growing animal industries because turkey meat is an inexpensive source of protein. For a long time, breeders have looked for a way to increase the use of artificial insemination to exploit the best turkey genes. Centralizing toms for semen collection would let breeders select and breed with only superior birds.

Oddly enough, the first giant step toward turkey stud farms—artificial insemination—was established over 20 years ago, but not to improve breeding. In fact, just the opposite occurred. Wide-breasted, heavy turkeys bred in the 1950's and 1960's struggled with

At the Cooper Hatchery, Oakwood, OH, Jim Webb collects semen from tom turkeys. Each of Cooper's three stud barns houses 550 toms from which semen is collected twice a week. (0585X446-8A)





Top Left: Each breeder barn at Cooper Hatchery houses 3,500 laying hens. In 1984, Cooper hatched 6,500,000 poults. (0585X448-13)

Top Right: Newly hatched male and female poults are separated by sharp-eyed Andrew Kim who heads a five-person crew that each day determines the sex of 50,000 birds to satisfy buyers who want only toms or hens for their "grow-out" farms. (0585X456-27A)

Above: Cooper's stud farm manager Terry Allmandinger observes technician Beth Allmandinger determine percent of viable sperm from samples so insemination dosage can be adjusted to insure fertility. When mixed with extender, semen collected in just 1 week at the stud farm can inseminate 22,000 hens. (0585X447-5)

sex and often failed to mate naturally. Artificial insemination was introduced to improve fertility rates.

The actual barrier to stud farms was that turkey semen does not store well. Unlike semen of horses, cattle, or swine that can be frozen or refrigerated for wider distribution in breeding, sperm cells from turkeys wouldn't stay viable even during short-term storage.

Then, in 1980, Thomas Sexton and colleagues at the ARS Avian Physiology Laboratory at Beltsville, MD, found an answer.

Building on prior research, Sexton found that turkey semen mixed at a one-to-one ratio with a special chemical medium can be kept at refrigerator temperatures for up to 6 hours using an automatic stirring device without loss in viability. Stirring the mix prevents sperm from settling, losing mobility, and dying.

The medium is Beltsville Poultry Semen Extender, which includes various salts and sugars of balanced pH that Sexton has modified several times for semen from chickens, ducks, Aleutian Canada geese, seaside sparrows, whooping cranes, and now turkeys.

For the first time, the new semen-holding technique enabled stud farms to exist and gave to turkey breeders what all breeders covet: selection ability for rapid genetic improvements.

Before stud farms became feasible, there were males on every producer's farm, for every hen flock. Breeders had little chance to select and use the best toms. Now, fewer and better toms are kept. They are housed away from hen flocks. They carry superior genes for about 20 important traits, including fertility, egg production and hatchability, and body weight.

To see how the centralized stud farms help breeders, take genetic selection for body weight for example. Each tom is weighed at 18 weeks old, with the heaviest held for breeding. Turkey breeders can now keep only the heaviest 20 percent, instead of the previously used top 50 percent. The average breeder male, then, is heavier.

Also, semen from the 20 percent can now service more hens with the new capability to store and move semen to other hen farms after it is collected. Previously, toms on a particular farm only serviced hens on that farm.

Holding semen for just 6 hours, possible with the new commercial technique, is sufficient for dramatic genetic improvements, says Sexton, because of the integrated nature of today's poultry industries. "Many companies raise their own grains, mix their own feeds, breed their own stock, and process their own products.

Many have laboratories to diagnose disease and produce vaccines and have nutrition and feed testing programs, and they conduct taste panels for meat quality control," says Sexton.

These sophisticated companies then provide researchers with a clear and rapid measure of the value of the semen technique and the stud farm, says Sexton.

After a preliminary field trial in cooperation with North Carolina State University, the North Carolina turkey industry (the nation's largest) put the stud-farm concept to work.

"We demonstrated at Wampler Foods in Virginia that you can hold semen in commercial operations long enough to justify a stud farm," says R. Michael Hulet. "But the resulting inflated value of these toms makes it necessary to give them the best of conditions to prevent disease." Hulet is assistant professor in turkey research and extension at Virginia Polytechnic Institute and State University at Blacksburg, VA.

In 8 hours, workers can artificially inseminate the same number of hens that used to take 10. Eliminating toms from the flocks also creates space and feed rations for more hens, says Sexton.

In late 1984, Sexton surveyed four companies for feedback on their first years of stud farms in breeding. All four reported that the market turkey is now better than ever before.

Kenneth K. Krueger of Nicholas Turkey Breeding Farms in California says that stud farms "can mean an instant (one generation) difference to the producer of a 5-percent increase in body weight per turkey. Using this idea, we are making far more genetic improvements year to year than is any other segment of the livestock industry."

Kreuger, while at Hybrid Turkey Breeders in Canada, tested the first commercial stud farm several years ago. "They really can't miss," he says. "We can expect consistently higher quality turkeys".—**Stephen Berberich**, Beltsville, MD.

Thomas Sexton is located at the USDA-ARS, Avian Physiology Laboratory, Bldg. 262, BARC-East, Beltsville, MD 20705. ■

Top: Incubating turkey eggs are candled for fertility by John Moore and Jessie Jones. Cooper Hatchery has more than 900,000 eggs incubating at any one time. (0585X450-14A)

Above: In the last step before shipment, Cooper employees Betty Shafer (left) and Cheryl Early inject poults with vitamins to strengthen them for their journey. They have already been debeaked and had their toes clipped by laser to keep them from harming each other. (0585X459-5A)

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The War Against Hessian Fly

ARS entomologist Jim Hatchett (left) and cooperating Kansas State University wheat breeder Rollin Sears examine Hessian fly-resistant wheat plants derived from wheat-goatgrass crosses. (0285X172-4)

The Hessian fly, the most destructive insect pest of wheat in the world, has been controlled on winter wheat in the United States for nearly 30 years. So far, the battle has been won, not with chemical pesticides, but by breeding genetic resistance in the wheat plant.

But while the Hessian fly may be down, it can't be counted out. David Keith, University of Nebraska entomology professor, writes that "the Hessian fly is still lurking around the edges of fields in the American wheat belt. We never know when the fly might change genetically and again become a threat to our wheat crop." As a result, the fly continues to be of intense interest to entomologists in this country and abroad.

The culprit is two-winged and black, about the size of a mosquito. There is evidence that the insect first invaded Long Island during the American Revolution, from infested wheat straw brought by Hessian mercenaries. Since then, the fly has proved a much more dangerous foe than the soldiers from Hesse, reducing wheat yields over the years by untold millions of bushels. The pest is found in all major wheat-producing areas of this country.

Its scientific name is particularly apt: *Mayetiola destructor*. In the spring and fall, the adult female lays 250 to 300 reddish eggs on leaves of newly emerging wheat. In a few days, larvae migrate from the base of the plant to its lower leaves and feed for about a month on the plant's juices. The result is a low-yielding, stunted wheat. Winter wheat is often weakened too much to survive the cold.

"We are talking here about an ancient enemy," says Jim Hatchett, research entomologist for USDA's Agricultural Research Service at Manhattan, KS. "Wheat as we know it today *(Triticum aestivum)* first appeared in the Middle East some 10,000 years ago, the result of natural hybridization of three wild grasses. About the same time, the Hessian fly discovered that it preferred this new wheat plant to its wild ancestors. The two species have coevolved, each

changing genetically from time to time in response to changes in the other.

"A wheat would develop resistance to the fly, and then a new fly strain would appear that was able to overcome that resistance. After 10,000 years, both wheat and fly have gotten pretty good at the game."

Wheat breeders and entomologists have learned the game, too, and in a lot less time. Since the fifties, for example, cooperative research teams from Agricultural Research Service and state agricultural experiment stations have bred one wheat after another that is resistant to the Hessian fly.

Hessian fly is causing heavy winter wheat losses this spring in the Southeast, where several nonresistant varieties have been planted. In five Alabama counties, the fly has reportedly cut yields from 50 to 100 percent. Serious damage has also been reported in coastal South Carolina and southeastern Georgia. Another ARS entomologist is being transferred to West Lafayette to work with ARS entomologist John E. Foster evaluating wheat varieties for the Southeast.

In some parts of the country, control has been so complete that today many of the new generation of wheat farmers have never seen fly damage.

Not long ago, it was a different story. The old rule of thumb is that if a farmer has 20 percent of a crop infested by Hessian flies, there will be "economic loss." By that rule, wheat growers in the central Midwest and Great Plains before the fifties invariably suffered losses. In the worst years, fly infestations ran as high as 70 percent in many fields. Damage from the pest has been estimated at $100 million in a single year.

Efforts at control on winter wheat once centered on planting in the fall, after the so-called "Hessian fly-free date," so that plants would not emerge until after most of the females had laid their eggs and died. The fly-free date, which is based on averages of temperature, varies in different parts of the country and even with local conditions. It worked better in some years than in others—but rarely prevented economic loss. Planting after fly-free dates is still recommended, however, to keep down fly populations.

Another cultural practice to control flies called for destroying any volunteer wheat promptly, since it can serve as a host for the fly during the summer and early fall.

"That used to be good advice—and it still is," says Hatchett, "but it doesn't produce results if just one farmer does it. You have to get rid of volunteer wheat all through a farming community for the practice to do much good. Today, with conservation tillage practices becoming more popular, a lot of farmers apply herbicides for broad-leaved weed control, but they ignore the volunteer wheat. That's a mistake."

But even the most dedicated community campaigns failed to get Hessian fly under control until strains of wheat were found that were resistant to the insect and the resistant genes bred into adapted, high-yielding cultivars.

Research by ARS and state experiment station scientists on this project began at Purdue University, in West Lafayette, IN, and Kansas State University in the forties, with a multidisciplinary team of breeders, entomologists, and plant pathologists. The teams were encouraged in the late forties by release of the first hard red winter wheats resistant to Hessian fly—'Ponca' and 'Pawnee'. In 1955, the first fly-resistant soft red winter wheat was released cooperatively by Purdue University and ARS. Named 'Dual', the wheat contains an H3 gene with specific resistance to the fly.

In the years since 'Dual' was released, there has been only 1 year when fly infestations in Indiana climbed temporarily above 20 percent, into the economic loss zone, according to John E. Foster, ARS research entomologist at West

Top: Hessian fly female does not feed and will live for only a few days. Females mate but once, then search for wheat plants on which to lay their eggs. (0476X350-23)

Above: Ten-day old Hessian fly larvae (actual size is 4 mm or about one-sixth inch) feed on a wheat seedling. Feeding causes stunting of the plant. How larvae obtain food from the wheat plant remains one of the unsolved mysteries of the Hessian fly. (PN-7157)

Scanning electron micrograph of 2-day old Hessian fly larva reveals highly specialized mandibles that may be used to inject salivary fluid into plants. Scientists believe fluid may inhibit plant growth and increase cell wall permeability, allowing the larva to suck out the plant's juices. (PN-7158)

Lafayette. By 1963, he says, more than 80 percent of Indiana wheat acreage was planted to fly-resistant cultivars, and they enjoyed similar popularity throughout the central Midwest.

All told, by 1982, 21 ARS-Purdue wheats had yielded some 1.5 billion bushels more wheat than the best of the old nonresistant wheats, 'Trumbull', would have produced. That adds up to $2.8 billion in additional returns to farmers.

"Using simple division," says Foster, "ARS-Purdue teams have been responsible for research returns of nearly $4.5 million per worker-year on the wheat-breeding projects. And that estimate is conservative; it includes 25 years of research prior to development of the first resistant variety."

But the war against the fly goes on. Hatchett reports that in some wheat areas of the Midwest, the old H3 gene isn't resistant anymore, although it remains effective against the fly in the Great Plains.

"From Missouri east to Indiana, a wheat named 'Arthur' and several other cultivars with the single H3 gene for resistance are failing to hold up under attack," Hatchett says. "Even 'Arthur 71', which has two genes for resistance (H3 and H5), is showing signs of susceptibility to the fly in some states." It is apparent that virulent biotypes have increased in numbers as a result of selection by resistant cultivars.

For the time being, he says, Midwestern farmers can play it safe by planting such soft wheat cultivars as 'Caldwell', 'Auburn', 'Fillmore', and 'Compton'. "They all carry the H6 gene for resistance, and H6 is still operative." And with the recent discovery of other resistance genes (H9, H10, H11, and H12) now being used in breeding programs, Hatchett is confident that ARS and university wheat breeders are still at least 20 years ahead of any virulent biotype of the fly that might seriously threaten wheat production. He warns, however, that to stay ahead of the Hessian fly into the next century, when food production will become more critical, new sources of resistance must be found today.

Wild Relatives May Hold The Answer

The search for resistance genes continues. Where does one find them? Hatchett and Bikram Gill, cytogeneticist at Kansas State University, believe the wild relatives of wheat may hold the answer. Wheat's wild ancestors still retain many genes for resistance to the parasites of cultivated wheat, including the Hessian fly. During the past 3 years, Hatchett and Gill have extensively evaluated these wild relatives for resistance to Hessian fly and other pests.

The wild wheat collection under study, which was obtained from the University of California at Riverside, contains more than 2,000 accessions of *Triticum* and *Aegilops* species originally collected in the Middle East. According to Hatchett, numerous sources of resistance have been identified in the wild wheats. The most promising is a wild species called goatgrass, which appears to have a wealth of genetic variation for resistance to Hessian fly. More than half of the goatgrass accessions tested were resistant to the most virulent biotype in the laboratory. The resistant accessions came from a region around the Caspian Sea in northern Iran and the southern U.S.S.R.—the area believed to be the original home of the Hessian fly.

What makes goatgrass such a valuable source of resistance, says Hatchett, is that it is one of the direct progenitors of wheat. Gill has already successfully transferred several Hessian fly resistance genes from goatgrass to common wheat. However, it will take wheat breeders a number of years to improve these wheats and develop high-yielding resistant cultivars. Nevertheless, the resistance genes Hatchett and Gill are identifying in wild wheats today may very well be the ones that will protect wheat crops from the Hessian fly in the 21st century.

Meanwhile, Foster hunted for Hessian fly resistance in the ARS National Small Grains Collection of 4,559 spring wheats from all over the world. To his delight, he found 13 new resistant strains. "But the real challenge," he says, "is still ahead of us—determining whether these wheats carry different resistance genes and learning how to manipulate them in breeding programs to slow down the evolution of fly biotypes. If we can do that, then we may be able to extend the useful life of the genes."

The next important step, he says, is to understand the chemical basis of resistance in wheat. "To do that, we have to learn much more about the physiology of the wheat and the physiological mechanisms by which the fly overcomes the resistance."

To help prepare the research stage for the genetic engineer, Foster has added to his staff Richard H. Shukle, an entomologist with a background in biochemistry. Shukle was brought aboard in 1981 in the first group of ARS research associates and is currently following up on several hypotheses. He has suggested that certain digestive enzymes apparently associated with fly larvae are used to break down the cell walls and intercellular matrix material of the wheat plant, thereby permitting the larvae to feed on cell content.

Shukle also feels that these enzymes, which include a pectinase, may be targets for enzyme inhibitors in the plant's tissues or may act as protein "signals" in a hypersensitive response. In such a hypersensitive response, plant cells in close proximity to larvae would die and release toxic

materials as a result of a stimulus produced by the larvae.

Shukle has already succeeded in the partial purification and characterization of a major digestive proteinase in the midgut of the fly larva. He has also determined that something called the "Bowman-Birk inhibitor," a proteinase inhibitor from soybean seeds, can completely inhibit digestion of proteins in the midgut of the Hessian fly larva.

"It is interesting to speculate," says Shukle, "that the gene for the Bowman-Birk inhibitor, which has been cloned, might be used through genetic engineering to construct wheat cultivars with resistance to the fly."

Shukle feels it is essential to understand the chemical basis of resistance to the Hessian fly in wheat and grasses related to wheat, such as the *Agropyron* spp., if gene transfer is to be used to create wheat cultivars with Hessian fly resistance.

And research leader Foster adds: "Today we are closer to mapping the genes of the Hessian fly than any other insect pest of crops. We know a great deal about their genes now and about the corresponding genes for resistance in wheat. Richard Shukle and other researchers are helping us prepare for the next big step forward."—**Hubert Kelley**, Beltsville, MD.

John E. Foster and Richard H. Shukle are at USDA-ARS Insect Control Research, Purdue University, West Lafayette, IN 47907. Jim Hatchett is at USDA-ARS Plant Science and Entomology Research, Department of Plant Pathology, Kansas State University, Manhattan, KS 60506. ■

'Adder' is Latest Hessian Fly Weapon

Late this year, the ARS-Purdue small grains breeding team will release 'Adder,' a new soft red winter wheat that is resistant to the Hessian fly.

Adder also resists the root rot wheat diseases "take-all" and *Rhizoctonia*.

The new variety has a genetic potential of more than 100 bushels per acre under optimum conditions, the breeders report.

Adder is the 22nd new wheat variety developed by the ARS-Purdue team during the last 30 years.—**H.W.K.**

Kansas State University cytogeneticist Bikram Gill takes pollen from goatgrass, which he will transfer to the floret of a wheat spike (left), to produce hybrid seed. Goatgrass, a wild ancestor of wheat, is a promising source of resistance to Hessian fly. (0285X171-1A)

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Wipe Away Wayward Weeds

A rotary herbicide wiper may do for tree crops what the rope-wick appli cator and other devices have done for row crops—allow a more efficient and safe way to apply herbicides.

William V. Welker, weed scientist, and Donald L. Peterson, agricultural engineer, developed the rotary wiper at the Agricultural Research Service's Appalachian Fruit Research Station at Kearneysville, WV.

The wiping pad on the device is made of polyurethane foam in the shape of a large, somewhat flattened donut lying on its side. A strong, heavy brushed denim covers the foam pad, which is held in place by a wooden disk above and below the pad's horizontal surfaces.

The wiping pad rotates parallel with the ground, at adjustable heights and speeds, and a circular pipe, with very small holes about 4 inches apart, distributes the herbicide inside the pad. The wiping disk rotation and the forward motion of the wiper combine to give excellent contact with weeds.

A free-rotating wheel larger in diameter than the wiping pad is mounted just above the pad. When the wiper moves along a row of trees, a tire on the wheel rolls gently around each tree trunk. This simple design avoids expensive hydraulic systems to maneuver the wiper in and out around the trees. The bumper wheel also keeps the herbicide-laden wiping pad from touching the trees.

The rotary herbicide wiper fills the need for equipment that makes the application of herbicides around horticultural crops much easier and more precise. Recent years have seen great strides in the selective placement of herbicides, including devices such as the rope-wick applicator, also developed by ARS.

Tests have shown that the wiper makes unnecessary repeated herbicide spraying to control weeds around horticultural crops. It has the added advantage of increased safety for both the operator and others, because there is no hazard of herbicide drift.

The wiper is equipped with either an 18- or 24-inch-diameter disk, depending on its use. The larger disk is used around fruit trees and the smaller one around

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No-Till Peaches Get Head Start

A weed scientist at the ARS Appalachian Fruit Research Station in Kearneysville, WV, says peach growers who plant their trees in killed sod rather than in the bare soil may be able to harvest a crop sooner.

Weed scientist William V. Welker and soil scientist D. Michael Glenn are experimenting with planting young trees in sod, instead of the usual bare, tilled soil. Within a week or two after planting, Welker kills the sod between and around the trees with a contact herbicide, glyphosate, at 2 pounds per acre. He follows this up with a residual herbicide once the sod is dead.

Each year, beginning in 1982, they planted 15 trees in killed sod and compared them with trees planted in: living sod kept mowed; bare, tilled soil kept weed free with cultivation; and, bare, tilled soil kept weed free with herbicide.

Six months after planting, the trees in killed sod had a 25 percent larger trunk diameter and a 45 percent wider foliage spread than those in bare, herbicide-treated or tilled soil. Welker says, "The mulch created by the dead sod sparks a dramatic increase in tree vigor and growth rate. Peach growers may be able to harvest a sizable crop in 3 years. Generally, 3-year-old trees bear only a few peaches."

The trees in living sod had the poorest growth of all; some trees did not survive the first winter.

Glenn says, "The new planting system appears to greatly improve the soil structure. The killed sod leaves a thin mulch that lasts about a year and a half. When the roots decompose, they probably release nutrients that help to fertilize the trees. The decayed roots also leave small pores that help air and water enter the soil. The dead sod also reduces water runoff, thereby increasing the amount of water stored in the soil."

Although Welker and Glenn are using peach trees, they say other fruit trees may also grow faster planted in killed sod.

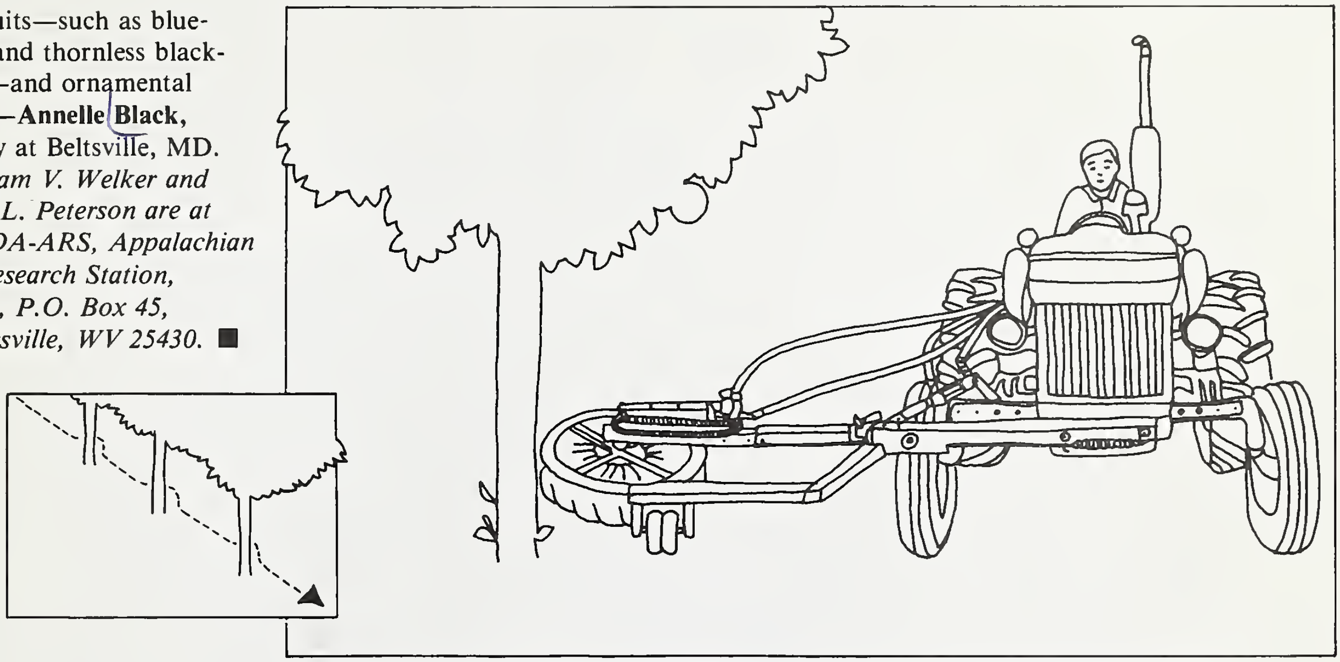
Orchard floor management is much more important than many growers realize, Welker says. The type of orchard floor affects the fertilizer program, weed control, orchard humidity, water penetration, soil aeration, disease incidence, and insect populations.

Many growers put trees in and give them minimal maintenance until they start to fruit, he adds. "That may be a costly mistake. A management system should be planned and started before the trees even go into the ground, because the growth a tree makes early in its first years contributes to its vigor and yield for the rest of its life."—**Annelle Black,** formerly at Beltsville, MD.

William V. Welker, Jr., and D. Michael Glenn are at the USDA-ARS, Appalachian Fruit Research Station, Route 2, P.O. Box 45, Kearneysville, WV 25430. ■

bush fruits—such as blueberries and thornless blackberries—and ornamental shrubs.—**Annelle Black,** formerly at Beltsville, MD.

William V. Welker and Donald L. Peterson are at the USDA-ARS, Appalachian Fruit Research Station, Route 2, P.O. Box 45, Kearneysville, WV 25430. ■



Orchard grower uses new rotary wiper to apply herbicide to weeds near trees. The herbicide is pumped from a tank mounted on the tractor into a circular foam pad sandwiched between two wooden disks. A free-rotating wheel with a bicycle tire rolls gently around each tree trunk, keeping the foam pad away from the tree while helping the wiper maneuver in and out around the trees. (See inset.)

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Small Computer Regulates Poultry House

With a simple new program, a small, inexpensive computer can regulate the environment of a poultry house.

Poultry production requires maintaining temperature and relative humidity within a narrow range. Until now, a skilled operator was required to make adjustments to control the environment in broiler houses, especially during periods of changing weather.

ARS agricultural engineer Floyd N. Reece developed the computerized environment concept and operating software. His program calls for sensing only the temperatures inside and outside the building. It omits measuring humidity, says Reece, "because there is a known and precise relationship between humidity and temperature."

The computer, using only two pieces of data and extrapolation, makes decisions every 5 to 10 minutes that control heating, lighting, and ventilation of a poultry house.

Small computers in the $200 price range that can be programmed in the computer language BASIC can make use of the software.

Says Reece, "We are confident that computers will control the environment in future poultry houses. The computer and the program are now part of our equipment, and we are currently using them in other experiments. Campbell Soup Company is using a computer with our program in a large poultry production system in Arkansas, and we have field tests underway in Alabama as well. This simple program is going to save money by cutting labor and feed costs, and it should simplify poultry production in general."
—**Bennett Carriere,** New Orleans, LA.

Floyd N. Reece is located at the South Central Poultry Research Laboratory, Mississippi State, MI 39762. ■

Broilers can be produced more efficiently in a computer-controlled environment. (0374A337-11A)

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PATENTS

Corralling the Coyote

Coyotes are by far the most serious predators of sheep in the United States. But the wily animals won't get near a trap or a chemical control agent unless the bait is highly attractive.

Now a group of synthetic compounds release scents common to coyote urine and rancid foods. The compounds not only act as strong scent baits, they cause coyotes to lick, chew, or bite the bait. This is essential when the control agent is a toxicant, antifertility agent, tranquilizer, or some other chemical that must be ingested. Furthermore, these responses can be tailored, depending upon which of the compounds are used and in what quantities.

Manufacturers of lures or specialty chemicals should be interested in the compounds—predominantly aldehydes and trimethylamine salts of fatty acids. They are readily synthesized from inexpensive, stable materials in sizable amounts and sufficiently pure form. They can be used alone or formulated with other additives such as taste attractants, antifertility agents, and so on.

For further technical information, contact Roy Teranishi, Western Regional Research Center, 800 Buchanan St., Albany, CA 94710. *Patent No. 4,472,377, "Method and Composition for Luring Coyotes."* ■

Low-Salt, Pickled Hot Dogs Last Longer

A way of pickling frankfurters and other emulsified meat products produces low-salt meats that can be stored for several months without refrigeration.

However, pickling can cause emulsified meat to become mushy, especially at higher temperatures. The inventor prevents this by adding about 0.5 percent of xanthan gum to the meat batter. The products retain their firmness and elasticity for several months at temperatures up to 90°F.

For further technical information, contact Jay B. Fox, Jr., Eastern Regional Research Center, 600 East Mermaid Lane, Philadelphia, PA 19118. *Patent No. 4,478,859, "Method of Making Stable Emulsified Meat Products."* ■

Machine Cleans Cotton Fibers Better

This apparatus should make working conditions safer in textile mills by reducing the amount of cotton dust in the air.

Opening and cleaning cotton tufts from bales of cotton releases fine trash and dust that contaminate the surrounding atmosphere.

As the tufts are opened, the dust and trash on the tufts' surface are removed, but particles of dust and trash are trapped in the matted tufts.

This new device removes foreign matter from the tufts before they become matted, trapping the dust and trash in a low-pressure stationary tube within a rotating cylinder.

For further technical information, contact Charles Shepard, Southern Regional Research Center, P.O. Box 19687, New Orleans, LA 70179. *Patent No. 4,479,286, "Apparatus to Extract Fine Trash and Dust During High-Velocity Discharging of Cotton From Opener Cleaner."* ■

Patents Available for Licensing

A catalog listing all U.S. Department of Agriculture patents is available on request. If you are interested in receiving the catalog or applying for a license on a patent, write to the Coordinator, National Patent Program, USDA-ARS, Rm. 401-B, Building 005, Beltsville Agricultural Research Center-West, Beltsville, MD 20705. ■